BACK TO BACK CONVERTER CONTROL TECHNIQUE USING MATLAB

MOHD AMRI BIN LAI DIN

A thesis submitted in partial fulfillment of the

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Faculty of Electrical & Electronic Engineering

University Malaysia Pahang

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"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Power System)"

Signature : _____

Name : MUHAMMAD IKRAM BIN MOHD RASHID

Date : 29 NOVEMBER 2010

UNIVERSITI MALAYSIA PAHANG

BORANG PENGESAHAN STATUS TESIS♦

JUDUL: **BACK TO BACK CONVERTER CONTROL TECHNIQUE USING MATLAB**

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Saya **MOHD AMRI BIN LAI DIN (881114065359)**
(HURUF BESAR)

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ABSTRACT

Back to back converter circuit model is a cascade circuit that a combination of AC to DC rectifier and DC to AC inverter. The AC input source firstly will converted to DC by using a rectifier and then will converted back to AC by using an inverter. Some application that using back to back converter is such as variable speed wind turbine that employ wound rotor induction generator and also HVDC transmission system. Generally, this project can be divided into three parts that is modeling rectifier station, inverter station and the controller for both station.

ABSTRAK

Pengubah arus terus kepada arus ulang alik dan pengubah arus ulang alik kepada arus terus boleh digabungkan menjadu satu pengubah yang boleh digunakan untuk pelbagai kegunaan. Sebagai contoh kegunaan pengubah ini ialah seperti sistem penghantaran arus terus bervoltan tinggi dan juga sistem turbin angin. Sumber arus ulang alik pada awalnya akan ditukar kepada arus terus menggunakan pengubah arus ulang alik kepada arus terus dan kemudian ditukar semula menjadi arus ulang alik dengan menggunakan pengubah arus terus kepada arus ulang alik. Umumnya, projek ini boleh dibahagikan kepada tiga bahagian iaitu pemodelan stesen pengubah arus ulang alik kepada arus terus, stesen pengubah arus terus kepada arus ulang alik dan juga pengawal untuk kedua-dua stesen pengubah.

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LIST OF SYMBOLS

V	-	Voltage
I	-	Current
Hz	-	Hertz
P	-	Real Pewer
Q	-	Reactive Power

LIST OF ABBREVIATION

HVDC	-	High Voltage Direct Current
DC	-	Direct Current
AC	-	Alternate Current
kV	-	Kilo Volt
kA	-	Kilo Ampere
P	-	Real Power
Q	-	Reactive Power
IGBT	-	Insulated Gate Bipolar Transistor

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CHAPTER I

INTRODUCTION

1.1 Background

During the latter part of the 19th century, electricity started to become increasingly important for society. The development of high-voltage-direct-current (HVDC) began in the mid 1920s. The first commercial HVDC Link carried power between the mainland of Sweden to the island of Gotland with 100V voltage level in 1954. Since then, the voltage and power level has been raised as shown in figure 1.1 in the next page[12];

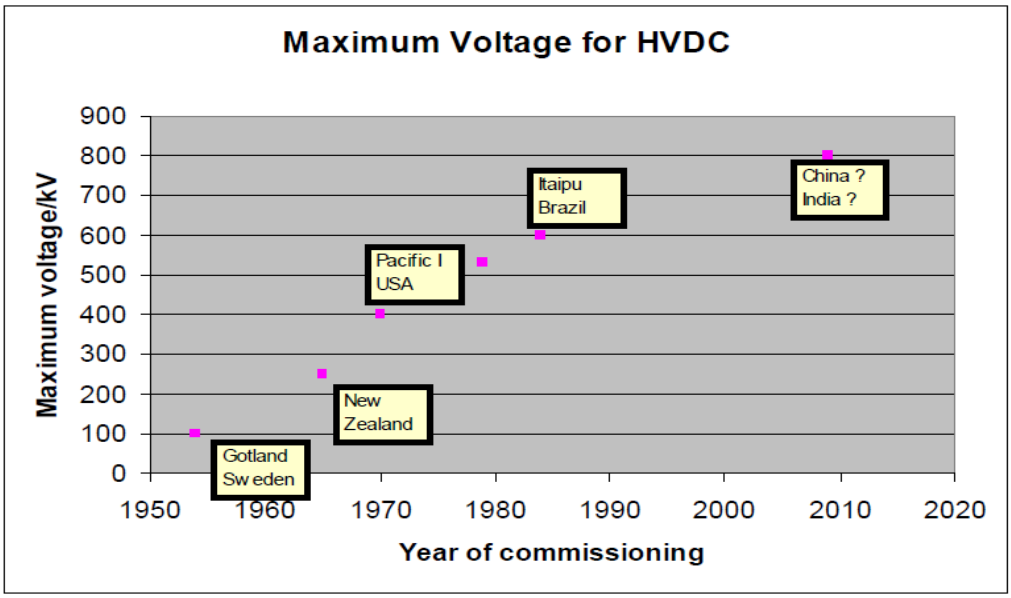


Figure 1.1 Development of HVDC[12]

High voltage direct current (HVDC) convert AC voltage to DC voltage in a rectifier and transmits DC power through the transmission line, and then reconverts DC into AC power in inverter and supplies the power. As a voltage, current and transmission power in the DC transmission can be controlled rapidly, when compared with the AC transmission, it is robust against a disturbance and increases a dynamic characteristic of AC power system and decreases a short-circuit capacity. The controllability of HVDC links is often cited as an important advantage of DC systems. This controllability can be valuable in improving the dynamic performance of large power systems. To achieve the promised advantages, control systems must perform appropriately for various disturbances and system condition. HVDC technology finds application in the transmission of power over long distances or by means of under water cable, and in the interconnection of differently managed power systems which may be operated synchronously or asynchronously[5].

Back to back converter is usually used in HVDC system that used widely in most of modern countries such as America and Japan. Back to back HVDC system also is very useful when two asynchronous AC systems need to be interconnecting. HVDC is used is for AC system stabilization reasons.

Because of HVDC nowadays is often used in most country, this project is about to study what is HVDC and to design and simulate one of few types of HVDC that is back to back HVDC link. Other types of HVDC will be discussed more in chapter 2. Back to back HVDC system is same with other type of HVDC. The only different is back to back is not for transmission. Both rectifier and inverter station is locate at the same place.

1.2 Objectives of the project

The main objective of this project is to develop a model of back to back converter using MATLAB/SIMULINK that will be interfaced with HVDC transmission system. This HVDC is to connect the two different systems that operate with different frequencies.

1.3 Scope of the project

The scopes of the project are:

- Design a back to back converter.
- Design the controller for inverter and inverter.
- Analysis about system fault in HVDC

1.4 Problem statement

This project is focused on the design of back to back converter that is very important to improve the transmission system nowadays. There is a major problem is transmission system now that transmit in AC such as can't make interconnection with two system with different frequency. AC transmission also has disadvantages that can be improved by HVDC such as to increase the capacity of an existing power grid, for power transmission stabilization and reducing losses.

1.5 Thesis outline

This thesis contains five chapters. Chapter I is about the project which consists of background, objectives, scopes and overview of the whole chapter.

Chapter II provides a literature review on general about HVDC system. This chapter discuss about overview of HVDC system, configuration of HVDC systems**,** physical structure and advantage of HVDC system.

Chapter III focuses on method that is being used including flow chart. The methods that being discusses consist of overview of the Whole System, back to back HVDC system model, converter transformer, thyristor, converter control system and DC link. This chapter also show some equation that being used to get some parameter of component.

Chapter IV discuses all the result base on objective while chapter V cover the conclusion, problem encountered and future recommendations for this project

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter presents an overview of high-voltage-direct-current (HVDC), and configuration, arrangement physical structure and the advantages of HVDC.

2.2 Overview of High-Voltage-Direct-Current (HVDC).

The power system begins from power plant. Inside the power plant, electrical power is producing by generator. From power plant, electrical power will transmit to transmission substation to step up by using transformer. From power plant to substation, the system operate in AC.HVDC is used at transmission line only. To convert AC to DC, rectifier is used. In the end of transmission line, inverter is used to convert DC to AC again. The next station is power substation. The electrical power will step down here and transmit to the load or user. The figure 2.1 shows the HVDC system in power transmission system[5].

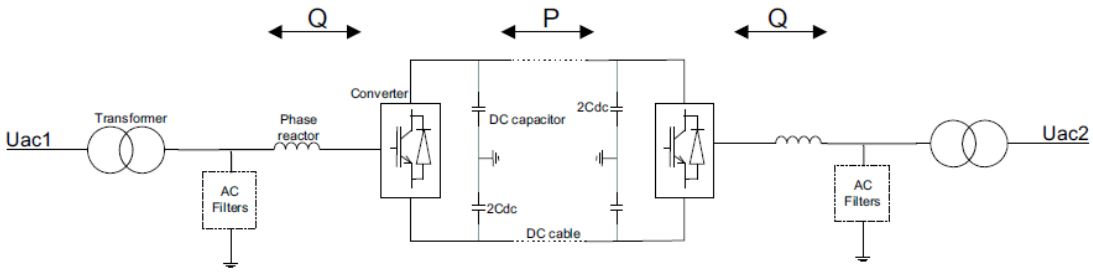
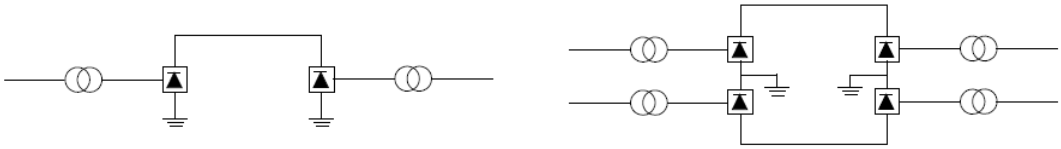


Figure 2.1 HVDC system[2].

Figure 2.1 show that how HVDC operate in two systems. As we know, the DC have only real power(P) not reactive power(Q) and apparent power(S). In DC, the value of frequency is equal to zero. So, the unsynchronized of AC can be combined together when the system convert to DC. Figure 2 show that how two unsynchronized of AC that have different value of frequency (60Hz and 50Hz) can be connected when using the HVDC. To convert AC to DC, rectifier is used and to convert DC to AC, inverter is used. In DC, there are no reactive component like inductance and capacitance. Capacitance is leading (+ve) and inductance is lagging (-ve).From the figure, after generation, transformer is used to step up the voltage. Transformer is used in AC only because transformer is component of inductance. After HVDC transmission, electrical power will convert to AC and step down by using transformer again[2].

2.3 Configuration of HVDC systems

HVDC converter bridges and lines or cables can be arranged into a number of configurations for effective utilization. Converter bridges may be arranged either monopolar or bipolar as shown in Figure 2.2 and are described as follow:



(a) Monopolar HVDC with earth return. (b) Bipolar HVDC

Figure 2.2 Monopolar and bipolar connection of HVDC converter bridges[1].

2.3.1 Monopolar HVDC system with earth return.

In monopolar links, two converters are used which are separated by a singlepole line and a positive or a negative dc voltage is used. In Figure 2.2 (a), there is only one insulated transmission conductor installed and the ground is used for the return current. For instance, the Konti-Skan(1965) project and Sardinia-Italy(mainland) (1967) project use monopolar links[2]. Instead of using the ground as a return path, a metallic return conductor may be used[1].

2.3.2 Bipolar HVDC

This is the most commonly used configuration of HVDC power transmission systems[2]. The bipolar circuit link, shown in Figure 2.2(b), has two insulated conductors used as plus and minus poles. The two poles can be used independently if both neutrals are grounded. It increases power transfer capacity. Under normal operation, the currents fowing in each pole are equal, and there is no ground current. In case of failure of one pole power transmission can continue on the other pole, so